PRICE $1.00

BENTON HARBOR, MICHIGAN

HEATHKIT®
ASSEMBLY MANUAL

HEATHKIT®

DECADE CAPACITANCE KIT

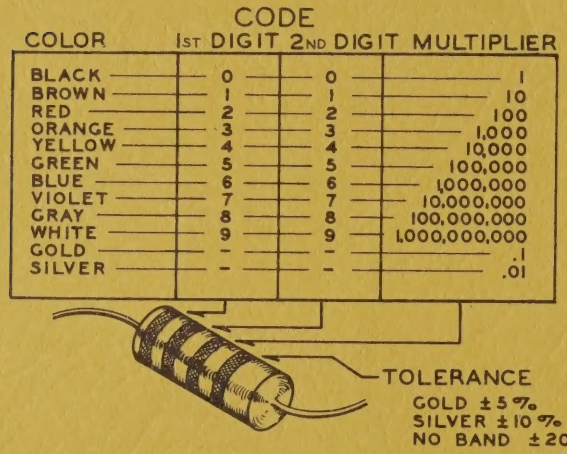
MODEL IN-21

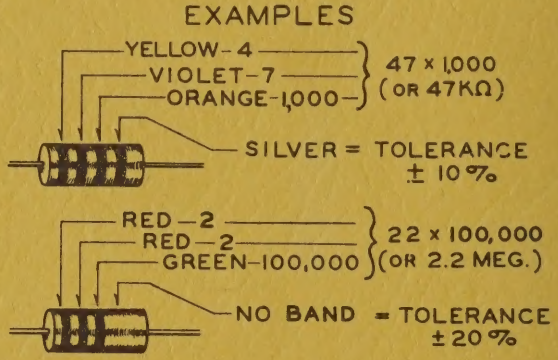
RESISTOR COLOR CODES

The colored bands around the body of a color coded resistor represent its value in ohms. These colored bands are grouped toward one end of the resistor body. Starting with this end of the resistor, the first band represents the first digit of the resistance value; the second band represents the second digit; the third band represents the number by which the first two digits are multiplied. A fourth band of gold or silver represents a tolerance of ±5% or ±10% respectively. The absence of a fourth band indicates a tolerance of ±20%.

The physical size of a composition resistor is related to its wattage rating. Size increases progressively as the wattage rating is increased. The diameters of 1/2 watt, 1 watt and 2 watt resistors are approximately 1/8", 1/4" and 5/16", respectively.

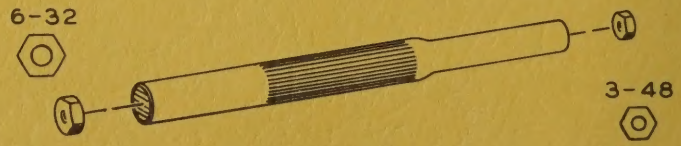
The color code chart and examples which follow provide the information required to identify color coded resistors.





USING A PLASTIC NUT STARTER

A plastic nut starter offers a convenient method of starting the most used sizes: 3/16" and 1/4" (3-48 and 6-32). When the correct end is pushed down over a nut, the pliable tool conforms to the shape of the nut and the nut is gently held while it is being picked up and started on the screw. The tool should only be used to start the nut.



Assembly

and

Operation

of the

HEATHKIT®

DECADE CAPACITANCE KIT

MODEL IN-21

All prices are subject to change without notice. The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

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SPECIFICATIONS

Range	100 $\mu\mu$f to 0.111 μfd in increments of 100 $\mu\mu$f.
Voltage Rating	350 volts DC, continuous; 500 volts DC, intermittent; 1000 volts DC instantaneous test.
Dielectric	Silver mica.
Accuracy Of Incremental Capacity	±1%.
Stray Capacitance	10 to 15 $\mu\mu$f at terminals.
Dimensions	7-1/8" wide x 4" high x 5" deep.
Net Weight	1-3/4 lbs.
Shipping Weight	3 lbs.

INTRODUCTION

The IN-21 Decade Capacitance Kit was designed as an accurate laboratory-type instrument for use where a wide-range, variable capacitor is necessary. A few of its many uses include substitution for: tuned circuit elements, bridge impedances, and filter elements. For speed and convenience, it is often more desirable to use the IN-21 to determine circuit capacitive values and, therefore, avoid involved calculations. The HEATHKIT Decade Resistance Kit makes an ideal companion with the IN-21 for solving resistance and capacitance networks where a large range of values are necessary.

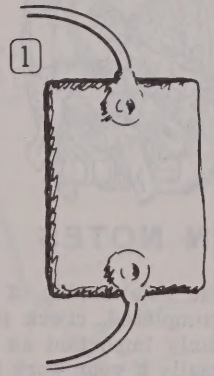
CIRCUIT DESCRIPTION

The circuit incorporates three convenient range switches to select any capacitance from 100 $\mu\mu$f to 0.111 μfd in 100 $\mu\mu$f steps. The silver mica capacitors that are employed exhibit a very low dissipation factor and internal resistance. As a range switch is rotated, it automatically selects one of, or a combination of, four silver mica capacitors and presents this capacity to the binding posts. The four capacitors of each switch are appropriately paralleled to complete the upper range of the switch.

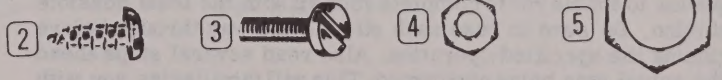
PARTS LIST

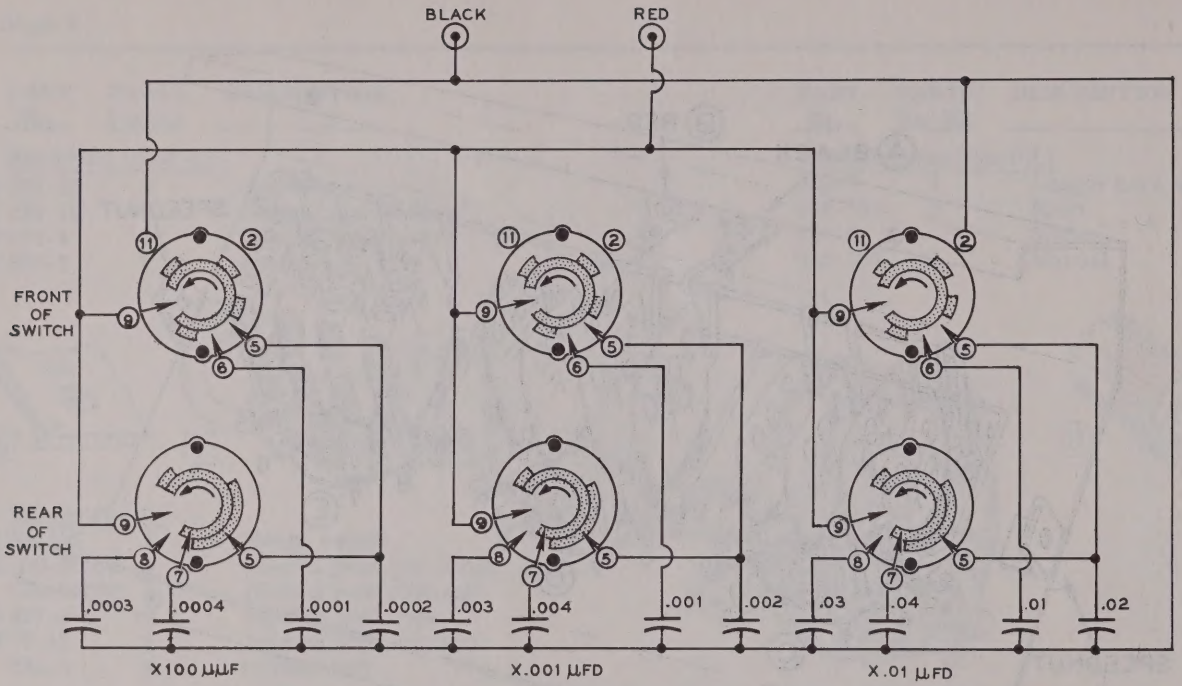
Unpack the kit carefully and check each part against the Parts List. The number in front of a part number corresponds to the picture of that part for quick and positive identification.

PART No.	PARTS Per Kit	DESCRIPTION
Capacitors (Silver Mica 1% 350 V)		
20-13	1	.0001 μfd (100 pf)
20-14	1	.0002 μfd (200 pf)
20-15	1	.0003 μfd (300 pf)
20-16	1	.0004 μfd (400 pf)
20-17	1	.001 μfd (1000 pf)
20-18	1	.002 μfd (2000 pf)
20-19	1	.003 μfd (3000 pf)
20-20	1	.004 μfd (4000 pf)
20-21	1	.01 μfd (10,000 pf)
20-22	1	.02 μfd (20,000 pf)
20-23	1	.03 μfd (30,000 pf)
20-24	1	.04 μfd (40,000 pf)



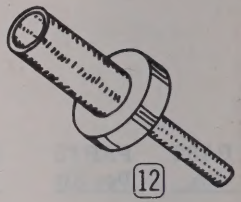
PART No.	PARTS Per Kit	DESCRIPTION
Sheet Metal Parts		
90-M205F	1	Cabinet shell
100-M368F659-660-680	1	Front panel
Hardware		
2 250-8	4	#6 sheet metal screw
3 250-89	2	6-32 screw
4 252-3	2	6-32 nut
5 252-7	3	Control nut





SWITCHES ARE VIEWED FROM REAR AND FULLY COUNTERCLOCKWISE

SCHEMATIC DIAGRAM
MODEL IN-21



HEATHKIT

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provided. This is particu-
rrors or omissions, espe-

In general, the illustrations in this manual correspond to the actual configuration of the kit; however, in some instances the illustrations may be slightly distorted to facilitate clearly showing all of the parts.

The abbreviation "NS" indicates that a connection should not be soldered yet as other wires will be added. When the last wire is installed, the terminal should be soldered and the abbreviation "S" is used to indicate this. Note that a number will appear after each solder instruction. This number indicates the number of leads that are supposed to be connected to the terminal in point before it is soldered. For example, if the instruction reads, "Connect a lead to lug 1 (S-2)," it will be understood that there will be two leads connected to the terminal at the time it is soldered.

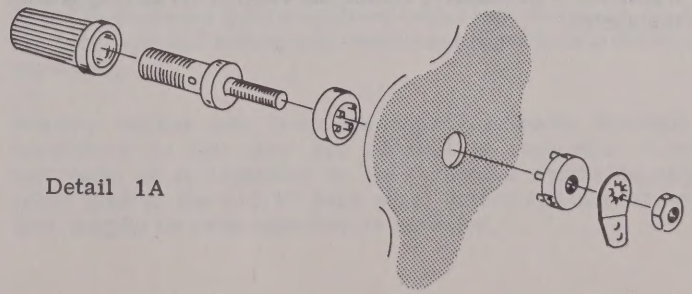
Position the work, if possible, so that gravity will help to keep the solder where you want it. The joint to be soldered should be heated with the flat side of the soldering iron tip sufficiently to melt the solder. Apply only enough solder to the heated terminal to thoroughly wet the junction. Remove the solder and then the iron when a smooth soldered junction appears. Do not move the leads until the solder is solidified.

ROSIN CORE SOLDER HAS BEEN SUPPLIED WITH THIS KIT. THIS TYPE OF SOLDER MUST BE USED FOR ALL SOLDERING IN THIS KIT. ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE EQUIPMENT IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. IF ADDITIONAL SOLDER IS NEEDED, BE SURE TO PURCHASE ROSIN CORE (60:40 or 50:50 TIN-LEAD CONTENT) RADIO TYPE SOLDER.

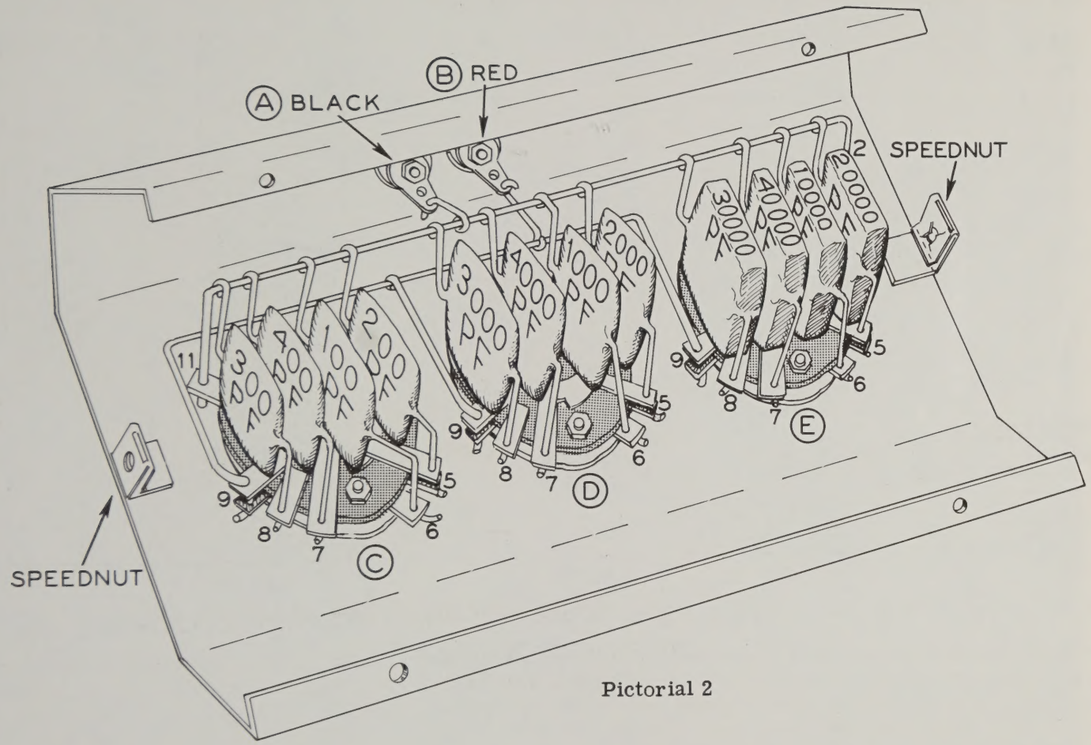
STEP-BY-STEP ASSEMBLY

Refer to Pictorial 1 on Page 7 for the following steps.

( ) Mount binding posts at A and B with black and red caps, respectively. See Detail 1A for assembly, using the binding post insulators. Note solder lug positioning as shown in Pictorial 1.

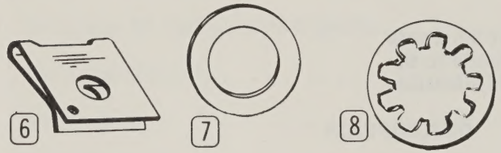


Detail 1A



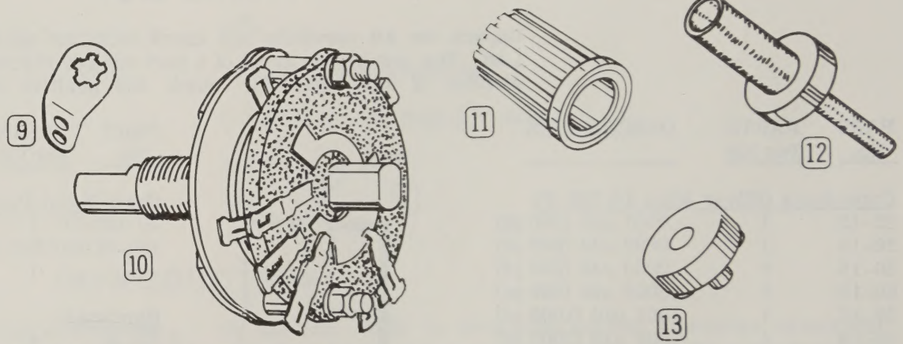
Pictorial 2

PART No.	PARTS Per Kit	DESCRIPTION
Hardware (cont'd.)		
6 252-22	2	Speednut
7 253-10	3	Control flat washer
8 254-4	3	Control lockwasher
9 259-1	2	Solder lug



Miscellaneous		
10 63-292	3	Range switch
11 100-M16B	1	Binding post cap, black
100-M16R	1	Binding post cap, red
12 427-2	2	Binding post base
13 75-17	4	Binding post insulator
261-4	4	Rubber feet

PART No.	PARTS Per Kit	DESCRIPTION
Miscellaneous (cont'd.)		
340-3	1	Length bare wire
462-187	3	Knob
331-6		Solder
595-507	1	Manual



CONSTRUCTION NOTES

The following instructions are presented in a logical step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before beginning the specified operation. Also read several steps ahead of the actual step being performed. This will familiarize you with the relationship of the subsequent operations. When the step is completed, check it off in the space provided. This is particularly important as it may prevent errors or omissions, especially if your work is interrupted.

In general, the illustrations in this manual correspond to the actual configuration of the kit; however, in some instances the illustrations may be slightly distorted to facilitate clearly showing all of the parts.

The abbreviation "NS" indicates that a connection should not be soldered yet as other wires will be added. When the last wire is installed, the terminal should be soldered and the abbreviation "S" is used to indicate this. Note that a number will appear after each solder instruction. This number indicates the number of leads that are supposed to be connected to the terminal in point before it is soldered. For example, if the instruction reads, "Connect a lead to lug 1 (S-2)," it will be understood that there will be two leads connected to the terminal at the time it is soldered.

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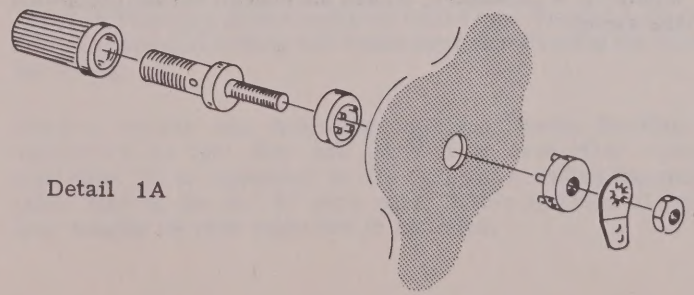
STEP-BY-STEP ASSEMBLY

Refer to Pictorial 1 on Page 7 for the following steps.

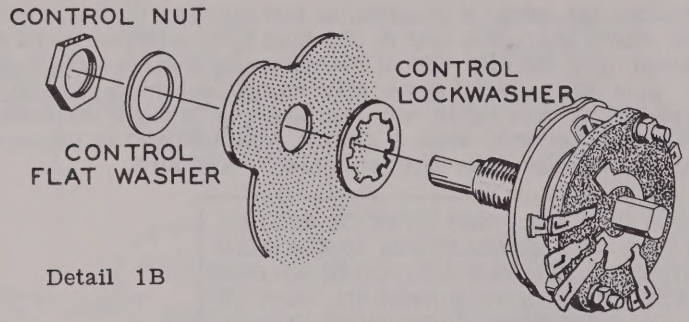
( ) Mount binding posts at A and B with black and red caps, respectively. See Detail 1A for assembly, using the binding post insulators. Note solder lug positioning as shown in Pictorial 1.



Detail 1A

Mount three range switches at the following locations. Refer to Detail 1B for assembly, and to Pictorial 1 for lug positioning.

( ) C ( ) D ( ) E



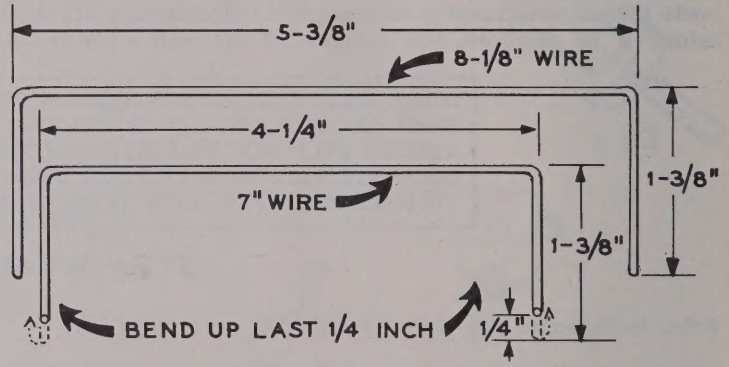
Detail 1B

( ) Mount the knobs on each of the switch shafts with the set-screw tightened to the flat side of the shaft. Make sure that each knob pointer is properly aligned with the switch numbers. If necessary, loosen the control nut and reposition the switch.

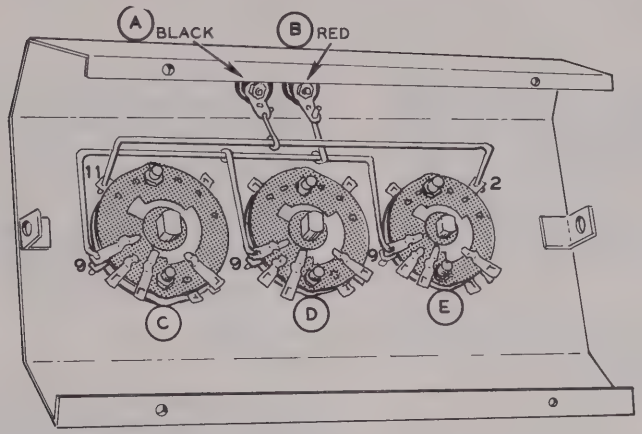
Refer to Pictorial 1 for proper wire positioning in the following steps.

( ) Unroll the coil of bare wire and stretch it to remove the kinks.

( ) Shape a 7" bare wire to the dimensions shown in Detail 1C. Connect this wire from lug 9 of range switch C (S-1) to lug 9 of range switch E (S-1). Make sure both double lugs are soldered.



Detail 1C



Pictorial 1

( ) Connect a 1-1/2" bare wire from lug 9 of range switch D (S-1) to the middle of the 7" bare wire (S-1). Make sure the double lug is soldered.

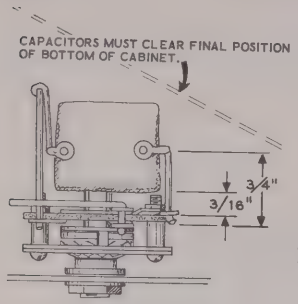
( ) Connect a 1-1/4" bare wire from the solder lug of binding post B (S-1) directly to the 7" bare wire (S-1). Crimp the end around the 7" wire as shown.

( ) Shape an 8-1/8" bare wire to the dimensions shown in Detail 1D. Connect this wire from lug 11 of range switch C (S-1) to lug 2 of range switch E (S-1). Do not permit the ends of this wire to penetrate more than 1/8" into their respective switch lugs.

( ) Connect a 2-1/4" bare wire from the solder lug of binding post A (S-1) directly to the 8-1/8" bare wire (S-1). Crimp the end around the 8-1/8" wire as shown.

Refer to Pictorial 2 (fold-out from Page 4) and Detail 2A (Page 8) for capacitor positioning and switch lug connections in the following steps.

Remove excess wax from the capacitor leads. Position the capacitors so that they are parallel to each other. Connect one lead of a capacitor to the indicated switch lug and the other lead to the 8-1/8" bare wire. Solder and clip off excess lead lengths as each capacitor is installed.



SUGGESTED DIMENSIONS OF LEADS AND PLACEMENT OF CAPACITORS.

Detail 2A

VALUE	SWITCH E, LUG
( ) 20,000 pf (.02 μfd)	5 (double lug)
( ) 10,000 pf (.01 μfd)	6
( ) 40,000 pf (.04 μfd)	7
( ) 30,000 pf (.03 μfd)	8

VALUE	SWITCH D, LUG
( ) 2000 pf (.002 μfd)	5 (double lug)
( ) 1000 pf (.001 μfd)	6
( ) 4000 pf (.004 μfd)	7
( ) 3000 pf (.003 μfd)	8

VALUE	SWITCH C, LUG
( ) 200 pf (.0002 μfd)	5 (double lug)
( ) 100 pf (.0001 μfd)	6
( ) 400 pf (.0004 μfd)	7
( ) 300 pf (.0003 μfd)	8

This completes the wiring. Check all the capacitors and other wiring for proper solder connections. Make sure that all of the capacitors have been connected to the proper switch lugs. Shake out any loose wire clippings.

( ) Place speednuts on the L brackets located on each end of the front panel. The flat side of the speednut should face toward the outside of the bracket.

( ) Install the four rubber feet on the bottom of the cabinet shell. The four large holes are for this purpose.

( ) Mount the cabinet shell to the front panel by inserting two 6-32 screws through the cabinet shell and into the L brackets. Insert four #6 sheet metal screws through the cabinet shell and tighten them into the bottom of the front panel. Your IN-21 may now be placed into operation.

OPERATION

The Decade Capacitance Kit is very simple to operate. Just connect it to the circuit under test and adjust the range switches for the particular capacitance needed. The total value of capacitance is found by adding the settings of the three range switches. For example; if the X.01 μfd range switch is set at 8 and the X.001 μfd range switch at 2, with the 100 μμf range switch at 0, the total capacitance presented at the binding posts will be .082 μfd. It should be kept in mind that approximately 13 μμf is always present at the binding posts and must be compensated for whenever it represents a significant portion of the total capacitance involved. In applications where this might be important, be sure the black binding post is connected to the lower impedance point in the circuit under test. It is not advisable to connect the red binding post to the lower impedance point because of the variation of stray capacitance that can exist at the binding posts. Regardless of application, the voltage limitations shown in the Specifications should be observed.

IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.

2. It is interesting to note that about 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered properly.

3. Check the values of the component parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.

4. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring beneath the panel.

SERVICE INFORMATION

SERVICE

If, after applying the information contained in this manual and your best efforts, you are still unable to obtain proper performance, it is suggested that you take advantage of the technical facilities which the Heath Company makes available to its customers.

The Technical Consultation Department is maintained for your benefit. This service is available to you at no charge. Its primary purpose is to provide assistance for those who encounter difficulty in the construction, operation or maintenance of HEATHKIT equipment. It is not intended, and is not equipped to function as a general source of technical information involving kit modifications nor anything other than the normal and specified performance of HEATHKIT equipment.

Although the Technical Consultants are familiar with all details of this kit, the effectiveness of their advice will depend entirely upon the amount and the accuracy of the information furnished by you. In a sense, YOU MUST QUALIFY for GOOD technical advice by helping the consultants to help you. Please use this outline:

1. Before writing, fully investigate each of the hints and suggestions listed in this manual under In Case Of Difficulty. Possibly it will not be necessary to write.
2. When writing, clearly describe the nature of the trouble and mention all associated equipment. Specifically report operating procedures, switch positions, connections to other units and anything else that might help to isolate the cause of trouble.
3. Report fully on the results obtained when testing the unit initially and when following the suggestions under In Case Of Difficulty. Be as specific as possible.
4. Identify the kit model number and date of purchase, if available. Also mention the date of the kit assembly manual. (Date at bottom of Page 1.)
5. Print or type your name and address, preferably in two places on the letter.

With the preceding information, the consultant will know exactly what kit you have, what you would like it to do for you and the difficulty you wish to correct. The date of purchase tells him whether or not engineering changes have been made since it was shipped to you. He will know what you have done in an effort to locate the cause of trouble and, thereby, avoid repetitious suggestions. In short, he will devote full time to the problem at hand, and through his familiarity with the kit, plus your accurate report, he will be able to give you a complete and helpful answer. If replacement parts are required, they will be shipped to you, subject to the terms of the Warranty.

The Factory Service Facilities are also available to you, in case you are not familiar enough with electronics to provide our consultants with sufficient information on which to base a diagnosis of your difficulty, or in the event that you prefer to have the difficulty corrected in this manner. You may return the completed kit to the Heath Company for inspection and necessary repairs. You will be charged a minimal fee, plus the price of any parts or material required. However, if the completed kit is returned within the Warranty period, parts charges will be governed by the terms of the Warranty. State the date of purchase, if possible.

Local Service by Authorized HEATHKIT Service Centers is also available in some areas and often will be your fastest, most efficient method of obtaining service for your HEATHKIT equipment. Although you may find charges for local service somewhat higher than for factory service, the amount of increase is usually

offset by the transportation charge you would pay if you elected to return your kit to the Heath Company.

HEATHKIT Service Centers will honor the regular 90 day HEATHKIT Parts Warranty on all kits, whether purchased through a dealer or directly from Heath Company; however, it will be necessary that you verify the purchase date of your kit.

Under the conditions specified in the Warranty, replacement parts are supplied without charge; however, if the Service Center assists you in locating a defective part (or parts) in your kit, or installs a replacement part for you, you may be charged for this service.

HEATHKIT equipment purchased locally and returned to Heath Company for service must be accompanied by your copy of the dated sales receipt from your authorized HEATHKIT dealer in order to be eligible for parts replacement under the terms of the Warranty.

THIS SERVICE POLICY APPLIES ONLY TO COMPLETED EQUIPMENT CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Equipment that has been modified in design will not be accepted for repair. If there is evidence of acid core solder or paste fluxes, the equipment will be returned NOT repaired.

For information regarding modification of HEATHKIT equipment for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic equipment stores.

Although the Heath Company sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for special purposes. Therefore, such modifications must be made at the discretion of the kit builder, using information available from sources other than the Heath Company.

REPLACEMENTS

Material supplied with HEATHKIT products has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information.

A. Thoroughly identify the part in question by using the part number and description found in the Manual Parts List.

B. Identify the type and model number of kit in which it is used.

C. Mention date of purchase.

D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. PLEASE DO NOT RETURN THE ORIGINAL COMPONENT UNTIL SPECIFICALLY REQUESTED TO DO SO. Do not dismantle the component in question as this will void the guarantee. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

SHIPPING INSTRUCTIONS

In the event that your equipment must be returned for service, these instructions should be carefully followed.

ATTACH A TAG TO THE EQUIPMENT BEARING YOUR NAME, COMPLETE ADDRESS, DATE OF PURCHASE, AND A BRIEF DESCRIPTION OF THE DIFFICULTY ENCOUNTERED. Wrap the equipment in heavy paper, exercising care to prevent damage. Place the wrapped equipment in a stout carton of such size that at least three inches of shredded paper, excelsior, or other resilient packing material can be placed between all sides of the wrapped equipment and the carton. Close and seal the carton with gummed paper tape, or alternately, tie securely with stout cord. Clearly print the address on the carton as follows:

To: HEATH COMPANY
Benton Harbor, Michigan

Include your name and return address on the outside of the carton. Preferably affix one or more "Fragile" or "Handle With Care" labels to the carton, or otherwise so mark with a crayon of bright color. Ship by insured parcel post or prepaid express; note that a carrier cannot be held responsible for damage in transit if, in HIS OPINION, the article is inadequately packed for shipment.

WARRANTY

Heath Company warrants that all Heathkit parts shall be free of all defects in materials and workmanship under normal use and service, and in fulfillment of such warranty Heath Company will, for a period of three months from the date of shipment, replace any part upon verification that it is defective.

The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment.

The foregoing warranty is completely void if corrosive solder or fluxes have been used in wiring the equipment. Heath Company will not replace or repair any equipment in which corrosive solder or fluxes have been used.

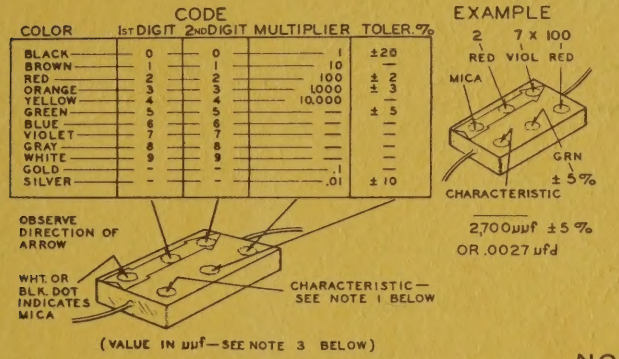
This warranty applies only to Heath equipment sold and shipped within the continental United States including APO and FPO shipments. Warranty replacements for Heathkit equipment outside the United States is on a f.o.b. factory basis. Contact the Heathkit authorized distributor in your country or write: Heath Company, International Division, Benton Harbor, Michigan, U.S.A.

HEATH COMPANY

CAPACITOR COLOR CODES

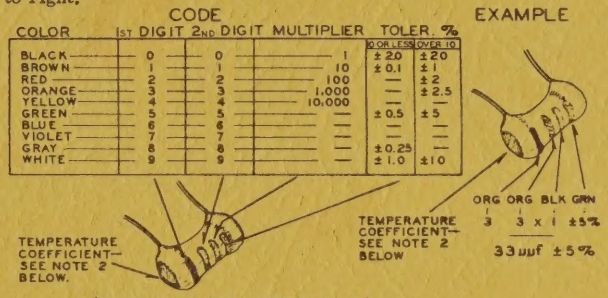
Generally, only mica and tubular ceramic capacitors, used in modern equipment, are color coded. The color codes differ somewhat among capacitor manufacturers, however the codes shown below apply to practically all of the mica and tubular ceramic capacitors that are in common use. These codes comply with EIA (Electronics Industries Association) Standards.

MICA



TUBULAR CERAMIC

Place the group of rings or dots to the left and read from left to right.


CODE
COLOR
1ST DIGIT
2ND DIGIT
MULTIPLIER
TOLER. %
10 OR LESS
OVER 10
BLACK 0 0 1 ±20 ±20
BROWN 1 1 10 ±0.1 ±1
RED 2 2 100 — ±2
ORANGE 3 3 1,000 — ±2.5
YELLOW 4 4 10,000 — —
GREEN 5 5 — ±0.5 ±5
BLUE 6 6 — — —
VIOLET 7 7 — — —
GRAY 8 8 — ±0.25 —
WHITE 9 9 — ±1.0 ±10
TEMPERATURE COEFFICIENT— SEE NOTE 2 BELOW.
TEMPERATURE COEFFICIENT— SEE NOTE 2 BELOW
(VALUE IN μμf—SEE NOTE 3 BELOW)
EXAMPLE
ORG ORG BLK GRN
3 3 X 1 ±5%
33μμf ±5%

NOTES:

1. The characteristic of a mica capacitor is the temperature coefficient, drift capacitance and insulation resistance. This information is not usually needed to identify a capacitor but, if desired, it can be obtained by referring to EIA Standard, RS-153 (a Standard of Electronic Industries Association.)

2. The temperature coefficient of a capacitor is the predictable change in capacitance with temperature change and is expressed in parts per million per degree centigrade. Refer to EIA Standard, RS-198 (a Standard of Electronic Industries Association.)

3. The farad is the basic unit of capacitance, however capacitor values are generally expressed in terms of μfd (microfarad, .000001 farad) and μμf (micro-micro-farad, .000001 μfd); therefore, 1,000 μμf = .001 μfd, 1,000,000 μμf = 1μfd.

HEATH COMPANY

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